TCAS II CHANGE PROPOSAL (CP)

DATE: 10 / 24 / 07 **No.:** **117**

TCAS II Version: **DO-185A (v7)** ____ **Other (Specify)** DO-185B

MOPS Function Area: **Surveillance** ____ **Display Req'ts** ____ **CRS** ____

Other **X** (Air-Ground Communication - Data Link Capability Report)

Priority: **URGENT** ____ **Necessary** X **Optional** ____

CP Type: **ERROR** ____ **Enhancement** ____ **Evaluation Request** ____

Other **X** (Compatibility with other standards documents)

Description of Problem/Issue:

In order to monitor the implementation and performance of DO-185B, the FAA and other Civil Aviation Authorities desire that TCAS version information be made available to Mode S ground sensors. To that end, a number of national and international organizations* have approved a change to the Data Link Capability Report to add a TCAS version indicator. The Data Link Capability Report already contains TCAS-related capability information which is generated by the TCAS unit, sent to the transponder via the ARINC 429 bus, and transmitted from the transponder to Mode S ground sensors. There will need to be a slight change to this TCAS-generated capability information.

* The organizations that have approved this change include RTCA SC-209, EUROCAE WG-49, ICAO Aeronautical Surveillance Panel, and AEEC General Session. The TCAS MOPS (DO-185B) should be updated to remain compatible with the standards of these other organizations.

Proposed Resolution:

There are four places in DO-185B where a change will be necessary:

Volume I, 2.2.3.9.3.2.3.2, "Subfields in MB for Data Link Capability Report"
Volume I, 2.4.2.2.5, "TCAS Capability Reporting"
Volume II, 1.3.10 "Interface: Data_Link_Capability_Report"
Attachment A, "PROCESS Send_owndata_to_trans"

See attached pages for a brief overview and detailed marked MOPS text.

Requester: Ann Drumm

Organization: MIT Lincoln Laboratory

DISPOSITION OF CHANGE PROPOSAL (Per RWG):

DATE OF DISPOSITION 12 / 11 / 07

Rejected _____ **Deferred** _____ **[Review Date:** ___ / ___ / ___ **]**

Accepted x **Modified** _____ **Withdrawn** _____

DISPOSITION OF CHANGE:

On Hold ____ **Designing** ____ **Testing** ____ **Done** x **[Date:** 12 / 11 / 07 **]**

Final Approval of Changes:

Signature: Andy Zeitlin, RWG Chair
Date: 12 / 11 / 2007

1. Data Link Capability Report – General Discussion

The Data Link Capability Report is contained in the 56-bit message field (MB) of a 112-bit Comm-B transmission downlinked from a Mode S transponder to a Mode S ground sensor. The first eight bits of the MB field, bits 33-40, are designated the B-Definition Subfield (BDS), with BDS1 = bits 33-36 and BDS2 = bits 37-40. The basic Data Link Capability Report used by TCAS is identified by BDS1=1 and BDS2=0. Five of the bits in the Data Link Capability Report are reserved for TCAS use: 48, 69, 70, 71, and 72.

1.1 Coding of Data Link Capability Report for Version 7 TCAS paired with Version 7-compliant Mode S transponder

This is the format that is in the current (DO-185A) MOPS.

Bit	Meaning
48	0= TCAS failed or on standby 1= TCAS operating
69	0= TCAS II 1= TCAS with horizontal resolution capability
70	0= TCAS generating TAs only 1= TCAS generating TAs and RAs
71	0= TCAS not fitted 1= TCAS fitted
72	always =0 (bit not used)

Note: Bit 71 currently can be used to distinguish between DO-185A format Data Link Capability Reports and FAA TSO-C119A format (Version 6.04A) Data Link Capability Reports. Bit 71=1 indicates a DO-185A format. Bit 71=0 indicates an FAA TSO-C119A format.

1.2 Changed Coding of Data Link Capability Report for Version 7.1 TCAS paired with Version 7-compliant Mode S transponder

This is the text that is proposed for DO-185B. The change will use bits 71 and 72 together to extend the coding of TCAS versions and will use bit 69 to indicate whether the TCAS unit is hybrid surveillance capable. Thus, the new coding proposed is:

Bit	Meaning
48	0= TCAS failed or on standby 1= TCAS operating

69	0= Hybrid surveillance not fitted 1= Hybrid surveillance fitted
70	0= TCAS generating TAs only 1= TCAS generating TAs and RAs

72	71	TCAS Version
0	0	RTCA DO-185 (Version 6.04A)
0	1	RTCA DO-185A (Version 7.0)
1	0	RTCA DO-185B (Version 7.1)
1	1	Future version (see registers $E5_{16}$ and $E6_{16}$)

1.3 Coding of Data Link Capability Report for Version 7 TCAS or Version 7.1 TCAS paired with a Mode S transponder not compliant with TCAS Version 7

There is no changed proposed here. This text will be the same in DO-185A and DO-185B.

Bit	Meaning
48	Bit 48=1 indicates that the TCAS/transponder interface is operational and that TCAS is reporting RI=2 or 3 for use in the air-to-air Reply Information field.
69, 70	On-board Resolution Capability Bits – Bits 69 and 70 form a capability code subfield which indicates aircraft's on-board resolution advisory generation capability. 0= No on-board RA generation capability 1= An on-board vertical-only RA generation capability exists 2= An on-board vertical and horizontal RA generation capability exists 3= Not assigned
71	always =0 (bit not used)
72	always =0 (bit not used)

2. Proposed Detailed Changes

The following pages contain text, statecharts, and pseudocode from DO-185A Volume I, Volume II, and Attachment A, respectively, with change markings to indicate the changes needed for DO-185B. The paragraph numbers shown here are the same paragraph numbers currently in draft DO-185B.

2.2.3.9.3.2.3.2 Subfields in MB for Data Link Capability Report

BDS: B-Definition Subfield – This 8-bit (33-40) subfield defines the data contained in the remainder of MB. For convenience in coding, BDS is expressed in two groups of 4 bits each, BDS1, 33 through 36, and BDS2, 37 through 40. All Data Link Capability Reports use BDSl=1. The basic Data Link Capability Report used by TCAS uses BDS2=0.

2.2.3.9.3.2.3.2.1 Coding of Data Link Capability Report - DO-185A,B Systems

Bits 48, 69, 70, 71, and 72 are used to convey TCAS capability information as follows:

Bit(s)	Coding
48	0 = TCAS failed or on standby 1 = TCAS operating
69	0 = Hybrid surveillance not fitted 1 = Hybrid surveillance fitted
70	0 = TCAS generating TAs only 1 = TCAS generating TAs and RAs
72, 71	TCAS Version 0, 0 = RTCA DO-185 0, 1 = RTCA DO-185A 1, 0 = RTCA DO-185B 1, 1 = Future version (see registers $E5_{16}$ and $E6_{16}$)

Deleted: 1

Deleted: TCAS II

Deleted: TCAS with horizontal resolution capability

Deleted: 71

Deleted: 0 = TCAS not fitted

Deleted: 1 = TCAS fitted

Deleted: *Note: Bit 71 can be used to distinguish between DO-185A format Data Link Capability Reports and FAA TSO-C119A format Data Link Capability Reports. Bit 71=1 indicates a DO-185A format. Bit 71=0 indicates an FAA TSO-C119A format.* ¶

2.4.2.2.5 TCAS Capability Reporting (2.2.3.13.2.2.4 and 2.2.3.13.2.2.1)

Note: See note on test operation in subparagraph 2.4.2.2.3.

This test verifies that the TCAS/transponder system properly communicates its TCAS capability to a ground Mode S sensor and to other TCAS aircraft. This includes passing TCAS capability information from TCAS to the transponder and transmitting this information in DF=0, DF=16, DF=20, and DF=21 replies. This test requires that TCAS demonstrate proper operation with both FAA TSO-C119A and RTCA/DO-185A compatible transponders.

Scenario A

Use manual selection on the control panel to select among the modes "stand-by," "TA-only", and "TA/RA." From T=0 to T=19 seconds, TCAS is in stand-by mode. From T=20 to T=39 seconds, TCAS is in TA-only mode. From T=40 to T=59 seconds, TCAS is in TA/RA mode. From T=60 to T=79 seconds, TCAS is in stand-by mode.

Input:

UUT:	Z	=	12,000 ft	at T=0
	ZDOT	=	0 fpm	from T=0 to 80
Int1:	Equip	=	TCAS II	
	R	=	6.2 nmi	at T=0
	RDOT	=	-360 knots	from T=0 to 80
	Z	=	10,500 ft	from T=0 to 80
	ZDOT	=	0 fpm	from T= 0 to 80
	Msgs	=	UF=0 from T=0 to 80, every second with AQ=0	
MSS:	Msgs	=	alternating UF=4 and UF=5 transmissions with RR=0 from T=0 to 80, every second; [i.e., UF=4 at T=0,2,4,…, 80, UF=5 at T=1,3,5,…, 79]	
			alternating UF=4, 5, 20, 21 transmissions with RR=17 from T=4 to 79, every 5 seconds; [i.e., UF=4 at T=4, 24, 44, 64, UF=5 at T=9, 29, 49, 69, UF=20 at T=14, 34, 54, 74, UF=21 at T=19, 39, 59, 79]	

Expected Output:

Msgs: DF=0 from T=0 to 80, every second. RI=0 from T=0 to T=20. RI=2 from T=21 to 40. RI=3 from T=41 to 60. RI=0 from T=61 to 80.

Alternating DF=4 and DF=5 transmissions from T=0 to 80, every second. DR=0 at T=0. Throughout the test, DR is set to 4 (or 5) within 4 seconds of a TCAS capability change and retains that value for 18 +/- 1s, unless superseded by a new capability change. DR then changes back to 0 if a capability change hasn't taken place, or DR toggles to the alternate value 5 (or 4) if a capability change has taken place and retains that value for 18 +/- 1s.

When testing with an FAA TSO-C119A compatible Mode S transponder:

Msgs: DF=20 with BDS=16, bits 48, 69, 70, 71, 72 = 00000 at T=4 and 64

DF=21 with BDS=16, bits 48, 69, 70, 71, 72 = 00000 at T=9 and 69

DF=20 with BDS=16, bits 48, 69, 70, 71, 72 = 10000 at T=24, 34

DF=21 with BDS=16, bits 48, 69, 70, 71, 72 = 10000 at T=29, 39

DF=20 with BDS=16, bits 48, 69, 70, 71, 72 = 10100 at T=44, 54

DF=21 with BDS=16, bits 48, 69, 70, 71, 72 = 10100 at T=49, 59

When testing with an RTCA/DO-185A compatible Mode S transponder:

Msgs: DF=20 with BDS=16, bits 48, 69, 70, 71, 72 = 0xy01 at T=4 and 64

DF=21 with BDS=16, bits 48, 69, 70, 71, 72 = 0xy01 at T= 9 and 69

DF=20 with BDS=16, bits 48, 69, 70, 71, 72 = 1x001 at T=24, 34

DF=21 with BDS=16, bits 48, 69, 70, 71, 72 = 1x001 at T=29, 39

DF=20 with BDS=16, bits 48, 69, 70, 71, 72 = 1x101 at T=44, 54

DF=21 with BDS=16, bits 48, 69, 70, 71, 72 = 1x101 at T=49, 59

Deleted: 00xx

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where x =0 if hybrid surveillance is not fitted; x=1 if hybrid surveillance is fitted
y=don't care

1.3.10 Interface: Data_Link_Capability_Report

Source: CAS

Destination: Mode_S_Transponder

Trigger Event: Effective_SL_Evaluated_Event$_{e\text{-}682}$

Condition:

Mode_S_Version$_{v\text{-}55}$ = Version_7	T

Assignments: None

Output Action: SEND(Data_Link_Capability_Report(BIT48, BIT69, BIT70, BIT71, BIT72)

Abbreviations:

BIT48 =

1	**if** (Effective_SL$_{s\text{-}97}$ **in one of** {2,3,4,5,6,7} **and** TCAS_Operational_Status$_{v\text{-}42}$ = Operational)
0	**Otherwise**

BIT69 = 0 ******* This bit must be set to 1 if hybrid surveillance is fitted*******

BIT70 =

1	**if** RA_Inhibit$_{m\text{-}416}$ = False **or** (Effective_SL$_{s\text{-}97}$ **in state** 1 **and** TCAS_Operational_Status$_{v\text{-}42}$ = Operational)
0	**Otherwise**

BIT71 = 0

BIT72 = 1

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Deleted: 0

Notes: *1.* ***Description:*** *The data link capability report is sent to the Mode S transponder for downlink to a ground station receiver.*

2. ***Pseudocode Reference:*** *Send_owndata_to_trans.*

```
PROCESS Send_owndata_to_trans;

    <Set up fields for SLC Update messages and data link capability report to transponder:>
    OWNDATA_TO_TRANS.SL = G.INDEX; <Indicate current sensitivity level>

    CLEAR OWNDATA_TO_TRANS.BIT_69; <***** This bit must be set to 1 if hybrid
surveillance is fitted*****>
    IF (G.INDEX GE 2 AND G.INDEX LE 7 AND G.OPFLG EQ $TRUE)
        THEN SET OWNDATA_TO_TRANS.BIT_48;
        ELSE  CLEAR OWNDATA_TO_TRANS.BIT_48;
              IF (G.OPFLG EQ $TRUE)
                  THEN SET OWNDATA_TO_TRANS.BIT_70;
                  ELSE CLEAR OWNDATA_TO_TRANS.BIT_70;

    IF (G.RAMODE EQ $TRUE)
        THEN OWNDATA_TO_TRANS.RI = 3; <Onboard TCAS with vertical-only RA
                                           capability>
             SET OWNDATA_TO_TRANS.BIT_70;
        ELSE  IF (G.TAMODE EQ $TRUE)
                  THEN OWNDATA_TO_TRANS.RI = 2; <Onboard TCAS with RA
                                                     capability inhibited>
                       CLEAR OWNDATA_TO_TRANS.BIT_70;
                  ELSE  OWNDATA_TO_TRANS.RI = 0; <No onboard TCAS>

    OWNDATA_TO_TRANS.VI = 1;
    CLEAR OWNDATA_TO_TRANS.BIT_71;

    SET OWNDATA_TO_TRANS.BIT_72;

    Send SLC Update message (i.e., SL, RI and VI) to transponder;
    IF (G.TRANSVI EQ 1)
        THEN send data link capability report (i.e., BIT_48, BIT_69, BIT_70, BIT_71, and
             BIT_72) to transponder;

END Send_owndata_to_trans;
```

Deleted: SET

Deleted: CLEAR